CORPS OF ENGINEERS IMPLEMENTATION OF PRESIDENT CLINTON'S CLIMATE CHANGE ACTION PLAN

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ABSTRACT

In 1993, President William Clinton's Climate Change Action Plan (CCAP) Initiative identified hydropower efficiency improvements as one of 44 actions intended to meet greenhouse gas (GHG) emission reduction goals by the year 2000. Since the Corps of Engineers owns and operates 75 hydroelectric projects, producing 25 percent of all hydropower in the United States, it plays a critical role in helping to achieve this objective for GHG emission reduction. Consequently, under Action #28 of the CCAP, the Corps was tasked with identifying potential generation improvements at it's hydroelectric projects. This action required surveying the existing Corps hydroelectric projects to determine the best potential candidates for generation improvement. Once these opportunities were identified, it was intended that the Department of Energy would issue requests for proposals from non-federal partners interested in financing the investments in these projects.

In order to identify the best potential projects for generation improvement, a contract was signed with Acres International Corporation to develop computer models to conduct qualitative and quantitative screening of the 75 Corps hydroelectric projects. An additional contract, with Apogee Research, Incorporated, was used to evaluate the potential for non-Corps investment in hydropower improvements at Corps-owned facilities should opportunities be identified through the screening process. The primary objective of this paper is to describe how the directives assigned to the Corps of Engineers under the CCAP were implemented.

The first screening model was developed for qualitative screening of the 75 Corps hydroelectric projects to determine the inherent potential for further study. This model was known as the Matrix

Model, and would be used to calculate the relative potential for generation improvement between the 75 projects based on a series of rating parameters and weighting factors for each project.

The second screening model, known as the Corps Generation Analysis Program, was developed to perform more detailed quantitative screening of the potential projects identified through the qualitative screening with the Matrix Model. The CGAP model computes such parameters as: (1) changes in average annual energy for various project improvements, (2) daily discharge changes associated with potential changes in reservoir storage allocation or operation policies, (3) corresponding reductions in GHG emissions associated with these changes, and (4) economic benefits and costs used to determine the feasibility of proposed improvements in generation. The final phase of the study would be to conduct the qualitative and quantitative screening of the 75 projects using the models that had been developed. Due to funding reductions, the final screening phase of the study was not completed; however, the screening models were developed for potential future screening and other evaluations.

Although the final phase of the study was not completed, there has recently been a renewed interest in efforts such as this to reduce GHG emissions. This is evidenced by the United Nations Conference on Global Warming held in Kyoto, Japan in December 1997. During this conference, the U.S. agreed to the principals of the Kyoto Protocol. This calls for the U.S. to cut GHG emissions 7 percent below 1990 levels in the period from 2008 to 2012. This renewed interest in reducing GHG emissions may lead to further refinement and utilization of the models developed by the Corps as part of the CCAP.

INTRODUCTION

> *We must take the lead in addressing the challenge of global warming that could make our planet and its climate less hospitable and more hostile to human life. Today, I reaffirm my personal, and announce, our nation's commitment to reducing our emissions of greenhouse gases to their 1990 levels by the year 2000. I am instructing my administration to produce a cost-effective planÿthat can continue the trend of reduced emissions. This must be a clarion call, not for more bureaucracy or regulation or unnecessary costs, but instead for American ingenuity and creativity, to produce the best and most energy-efficient technology.*

President Clinton
April 21, 1993

With this statement, President Clinton initiated the Climate Change Action Plan (CCAP). The plan's goals meet the twin challenges of responding to the threat of global warming and strengthening the economy. The CCAP identifies 44 actions aimed at reducing greenhouse gas emissions to 1990 levels by the year 2000. Implementation of Action No. 28, *Retain and Improve Hydroelectric Generation at Existing Dams*, by the U.S. Army Corps of Engineers, is the focus of this paper. The Corps' role in the President's plan is to identify potential generation improvements at existing Corps of Engineers' hydropower facilities and to explore opportunities for non-Federal investment in the improvements. The improvements would lessen greenhouse gas emissions by reducing the need to build additional fossil fuel plants, reduce the Federal deficit by exchanging hydropower development rights for lease payments to the treasury, and increase opportunities for business investment. This focus on reducing the threat of global warming has recently been renewed at the United Nations Conference on Global Warming held in Kyoto, Japan in December 1997. At this conference, the United States made a commitment to cut emissions of greenhouse gases to 7 percent below 1990 levels in the period from 2008 to 2012.

The Corps of Engineers currently operates 75 hydropower projects with approximately 21,000 megawatts of total production capacity. This total represents about one quarter of all U.S. hydropower capacity and nearly half of all federal hydropower. Based on these figures, Corps facilities contribute about 3 percent of all electric power generated in the U.S. Recent estimates indicate that there are about 32 Corps-owned hydropower projects that, with generation improvements, have the combined potential of adding approximately 3,000 megawatts (or 14 percent of current capacity) to existing Corps capacity.[1]

With its significant role in producing the nation's energy, the Corps' plays a critical role in implementing the CCAP objectives. The Corps' broad objectives for Action No. 28 were to: 1) Develop computer models to qualitatively and quantitatively evaluate the potential for generation improvements and reductions in greenhouse gas emissions; 2) Conduct screening of all 75 Corps hydropower facilities for generation improvement and greenhouse gas reduction potential and, as appropriate, conduct reconnaissance and feasibility level studies for those sites with high potential;[2] 3) Evaluate the potential for non-Corps investment in hydropower improvements at Corps-owned facilities.

MODEL DEVELOPMENT

As part of the implementation of the CCAP, the Corps had two computer models developed to perform qualitative and quantitative screening of the 75 Corps hydroelectric projects to determine the potential for generation improvements. Development of these models responds to the first major objective in the Corps implementation of the CCAP. The first model is known as the Matrix Model (MM), and was designed for the initial qualitative screening of the projects. The other model developed is the Corps Generation Analysis Program (CGAP). The CGAP model is used for quantitative screening of the potential projects that have been identified through the qualitative screening with the MM. The models were developed for use on a personal computer in the **FoxPro** 3.0 software environment using the Microsoft Access database. They were also designed to accept input data from the Corps HEC-DSS database as well as data in the U.S. Geological Survey database.

MATRIX MODEL

The purpose of the MM is to perform qualitative screening of hydroelectric projects as an initial step in identifying and evaluating opportunities for generation improvements. The qualitative evaluation at each site is made from various plant parameters by applying formulas and other criteria to compute a total evaluation number, which is a measure of the potential for generation improvement.

For conventional hydro plants, the MM considers the following three options: (1) upgrading of generating units (including peripheral electrical equipment), (2) plant expansion, and (3) operation improvements. For pumped storage plants, only upgrading of the generating units is considered.

For conventional hydro units, under the upgrade screening option of the model, the user can evaluate the option of upgrading either the generator or turbine. In either case, the model also assesses the peripheral electrical equipment to determine whether new equipment is needed to support the upgrade. To give a qualitative ranking of projects for turbine or generator upgrade, benefit factors for increased efficiency and capacity are calculated based on the potential for increased efficiency and/or capacity. These factors are combined to compute the Benefit Index for upgrading. A Benefit/Cost Index is also computed to represent the relative costs associated with the upgrade compared to the benefits.

The plant expansion component of the model will assess, on a

qualitative basis, the potential benefit of plant expansion at a particular facility. The user inputs (in cfs) a suitable plant flow increase they wish to calculate, and the MM calculates the incremental capacity and generation, based on the flow duration curve. The program makes an adjustment to the incremental generation to allow for the reduction in head due to higher tailwater levels resulting from the increased flows. The cost factor is based on an empirical formula incorporating power and head. The cost factor is lower for plants, which presently have space for additional units. The user can also input an adjustment factor to the cost to allow for difficult site access for construction and/or environmental concerns.

The operation improvements screening analysis option was designed to evaluate run-of-river plants, storage plants, and pumped storage plants with similar methodologies. The primary factors used in the operation improvements screening are user inputs for probability of changing operations, percent increase in energy from operation improvements, probability of increasing head at the plant, estimated increase in head, and the estimated costs.

The results of the qualitative screening evaluation of each conventional hydro plant are six numbers, two for upgrading, two for plant expansion, and two for operation improvements. One of the two evaluation numbers for each option is representative of the magnitude of the potential generation increase (Benefit Index). The second evaluation number is representative of the generation increase per dollar of capital expenditure (Benefit/Cost Index). For pumped storage plants, only two evaluation numbers are calculated because only unit upgrade is assessed for these plants.

CORPS GENERATION ANALYSIS PROGRAM

The CGAP model was developed to conduct quantitative screening of hydroelectric facilities to identify and evaluate the potential for generation improvement. This model requires an extensive database of detailed information about each unit in the powerhouse. Within this model are five modules used to analyze projects for generation improvement in a more detailed manner than the MM allows. The modules incorporated in the model include: (1) Data Module, (2) Turbine-Generator Module, (3) Energy Module, (4) Green House Gas Module, and (5) Economics Module. Each module is individually accessed from the CGAP main screen. Within each module is the capability to produce reports summarizing the results. The function and operation of these modules is described briefly below.

The Data Module provides access to hydrologic/hydraulic data

compiled for use in the CGAP model. This includes data in the Microsoft Access database format, the HEC-DSS database, and the U.S. Geological Survey discharge files in card image format. The module checks for completeness, format, and out of bound ranges, and provides a report on the results of the data check. Data selected for a particular simulation is compiled into a Data Scenario for that simulation.

The Turbine-Generator Module allows the CGAP user to evaluate, on a preliminary basis, the upgrade potential of hydro turbine equipment at a particular plant. It also provides the capability to evaluate expansion at a powerplant by adding new generating units. This evaluation includes an assessment of the generator and major electrical equipment at the facility. Once a particular combination of equipment has been selected from a simulation, it can be saved in a Turbine-Generator Scenario for future studies.

The Energy Module is used to create overall plant Upgrade Scenarios as well as to compute the corresponding energy generation potential for a particular scenario. An Upgrade Scenario is created by combining a Data Scenario (from the Data Module) with a Turbine-Generator Scenario (from the Turbine-Generator Module) and modifying the operating policies and data as necessary. Initially, an Upgrade Scenario representing existing conditions is created and saved. This scenario is designated as the “Base Scenario” and is used for comparison purposes with the other scenarios created. The average annual energy determined in the model can be computed using hourly or daily flows or flow duration data.

The Greenhouse Gas Module is used to calculate the reduction in greenhouse gas (GHG) emissions due to upgrading and/or expansion of a project. These emission reductions are a function of the fossil fuels consumed to produce the energy that can be displaced by the additional generation from the upgraded or expanded hydro project. The general methodology used for computation of Greenhouse Gas (GHG) emissions is described in the U.S. Environmental Protection Agency (EPA) AP-42 series, developed by the Emission Factor and Inventory Group of the EPA Office of Air Quality Planning and Standards. This series details the estimation of pollutant emissions through the use of Emission Factors. These factors are values that attempt to quantify the amount of a particular GHG pollutant released to the atmosphere as a function of a particular activity causing the release of that pollutant. They were developed by the EPA, based on emission control reports, as an estimate of the average GHG emissions per activity. The CGAP program has available the existing generation and the proposed generation for each plant,

as well as the state or region the plant is located in. The user then selects whether to use state or regional data for the determination of the percentage of thermal powerplant generation by source. The user also selects from two different types of GHG Reduction analysis, average reduction, or maximum reduction. The average reduction will reduce the generation from each type of GHG-emitting electrical generating source proportional to the generation by that source in that particular region or state. The maximum reduction option will reduce the generation from the maximum GHG-emitting sources.

The Economics Module provides financial analysis for comparing generation improvement alternatives, and to determine if the benefits and costs associated with an alternative warrant the proposed upgrade. It includes a database of estimated costs for upgrade and expansion of turbines and generators, transformers, bus, and switchgear. The economic analysis of project upgrades is assessed based on evaluation of a benefit and cost stream which will track the cash flow throughout the economic life specified for the project

SUMMARY

The MM and CGAP models provide a comprehensive package that can be used to effectively perform qualitative and quantitative screening of hydroelectric projects for potential generation improvements and reductions in GHG emissions. Although the models were not used to perform the qualitative and quantitative screening due to funding constraints, the models can still be used for screening analysis on specific projects or groups of projects.

THE POTENTIAL FOR NON-CORPS INVESTMENT IN HYDROPOWER IMPROVEMENTS AT CORPS-OWNED FACILITIES

This study was conducted by Apogee Research, Inc. for the Corps. The overall objective was to evaluate the potential for non-Corps investment in hydropower improvements at Corps-owned facilities. The resulting report provides background information on the legal, institutional, and administrative settings for development of Corps hydropower operations; discusses hydropower’s position in the energy industry and the impacts of the changing industry landscape on Corps operations; and presents public-private or public-public partnership models that are relevant to the institutional and financial components associated with Corps

hydropower generation improvements. The report then summarizes the results of a series of in-depth interviews conducted with potential non-Corps investors regarding their interest in making investments in generating improvements at Corps facilities. Finally, the report provides an overall evaluation of the potential for non-Corps investment in system upgrades, identifies areas that warrant further research and analysis, and offers recommendations regarding next steps for furthering consideration of non-Corps investment.

INSTITUTIONAL AND ADMINISTRATIVE SETTING FOR CORPS HYDROPOWER DEVELOPMENT

As aging hydropower facilities generate a need for increased federal spending on hydropower facility maintenance and structural rehabilitation, significant opportunities are also created to rehabilitate aged facilities with new, state-of-the-art technologies. Although the federal government is committed to fund the *maintenance* of original levels of power generation output and reliability at federal hydropower facilities, generation improvements beyond original output levels that do not relate to *reliability* are intended to be directly funded from non-federal sources. Current budgetary funding criteria specify that new facilities are to be funded through non-federal sources and that increased capacity and improved efficiency can *either* be funded through non-federal or federal sources, depending on whether there is a reliability concern driving the investment.

While the Corps has developed fairly clear guidelines for the appropriate role of non-federal financial participation in upgrade investments, institutional provision for the receipt of such funds has proven to be a considerable constraint. In general, federal agencies may not augment Congressional appropriations from outside sources without specific statutory authority. A significant recent legislative and administrative development is the implementation of Section 2406 of the National Energy Policy Act of 1992 which allows the Corps to accept funds from the Bonneville Power Administration (BPA) for all hydropower replacements, improvements, and operations and maintenance in the Pacific Northwest.

A number of additional legislative initiatives also could have substantial impacts on the institutions and administrative processes that govern federal hydropower development. Among the most significant are current efforts to privatize or sell the assets of federal power marketing agencies and deregulation of the electricity industry.

PARTNERSHIP MODELS

Private sector involvement in infrastructure projects has ranged from private ownership and operation of assets to short-term contracts for the provision of specific services such as design, construction, and operations and maintenance (O&M). In addition, private involvement may be limited to an upfront capital investment in exchange for a future stream of benefits from a government-owned and operated facility. Partnership contracts also may specify changing public and private roles and responsibilities throughout the life of an investment.

Private parties are attracted to partnerships when they believe the expected monetary or other economic benefits of the arrangement adequately compensate them for their investment. Alternatively, public partners enter into partnerships when they believe they can meet the needs of their local constituents at an attractive cost. All potential partners must be convinced that the rewards from a partnership will adequately compensate them for the risks of the venture and that returns meet or exceed returns they could receive from alternative investments of their time, money, and resources.

Successful partnerships result from matching government policy objectives with partners' economic objectives and from allocating risks among parties as efficiently as possible. The major objectives are to access non-Corps financial resources for hydropower upgrade investments in order to optimize the use of existing hydropower energy sources rather than develop new greenhouse gas emitting alternatives. The focus on financial resources, rather than operating or management expertise, suggests that developer financing partnership models are the most relevant to the desired objectives. Other types of partnerships, such as turnkey contracts and full privatization approaches, entail a much greater degree of involvement by private partners, and would require major changes to existing legal and institutional structures if they were to be used for Corps hydropower improvements.

INTERVIEW FINDINGS

To assess investor interest, and identify potential partnership structures and obstacles to implementation, representatives of 19 organizations identified as having a potential interest in the improvement projects being considered by the Corps were interviewed. Interviewees represented preference customers, Federal Power Marketing Agencies (PMAs), investor-owned utilities, private power producers, hydropower equipment manufacturers, and private power marketing firms. While efforts were made to interview a broad array of interests, the agencies selected do not represent a statistical sample of potential

investors and the results of these interviews should not be viewed as a comprehensive assessment of potential investor viewpoints.

Based on interviews conducted with representatives of the three broad classes of potential investors—preference customers, PMAs, and private investors involved in power generation and/or distribution—there appears to be significant interest in opportunities to enter into partnerships with the Corps to develop hydropower resources through generation improvement investments. The most immediate opportunities are found with current preference customers and PMAs. Where they have sufficient working capital or borrowing capacity, PMAs are interested in evaluating and potentially funding generation improvement investments. Where PMAs are not in a position to independently make investments, they might choose to work with individual preference customers or customer pools to facilitate investments in Corps projects.

While the most promising opportunities appear to be with PMA and preference customer investors, there is considerable interest beyond this inner circle in at least continuing discussions of potential investment opportunities. Interest in generation improvement investments by other investors is tempered, however, by substantial legal and regulatory obstacles. Private power developers and investor owned utilities are interested in providing capital for upgrades, however, many prefer or require that partnerships include opportunities for significant operational and/or ownership control.

A particularly interesting opportunity identified through the interviews was the potential for partnerships with equipment manufacturers, either independently or teamed with financial investors. Because these parties would not be interested in the power produced by the investment, issues related to preference can be avoided. Given their knowledge of the improvements, they also may be willing to take some of the output risk of the facility. Others expressing significant interest in investment opportunities include private power marketing companies. However, as with investor-owned utilities, investments from this class of investor face substantial legal and administrative barriers, including issues related to preference, power pricing, and environmental and regulatory risks.

ISSUES TO ADDRESS

Given the Corps' current legal and administrative environment, the federal government's privatization initiatives, and the desire to attract private investors for Corps improvement

projects, there are several issues which need to be addressed to continue to explore the potential for non-Corps investment in generation improvement projects at existing facilities. These include:

- Examining how other authorized purposes for water resource projects may affect generation improvement investments and exploring mechanisms to reduce these impacts; and

- Determining the economic viability of individual projects and creating investment incentives for non-federal investors.

CONCLUSIONS

This paper has described how the Corps of Engineers fulfilled two of the three major objectives for Action No. 28 of President Clinton's CCAP initiative. Through a contract with Acres International Corporation, computer models were developed to qualitatively and quantitatively evaluate the potential for generation improvements and reductions in GHG emissions. As a part of this work, a limited amount of qualitative and quantitative screening of some Corps projects was performed in order to verify and calibrate the models. Although funding is currently not available to conduct any further screening, the next objective of the study is to conduct this screening should an alternate source of funding become available. In addition to the model development, through a contract with Apogee Research, Inc., a report was prepared evaluating the potential for non-Corps investment in hydropower improvements at Corps-owned facilities.

While discussions conducted with potential investors indicate there is significant interest in exploring upgrade projects at Corps hydropower facilities considerable work remains. If additional funding were available, the immediate next steps would be to:

- Further evaluate and develop priorities among potential partnership types;

- Further specify improvement projects;

- Consult with PMAs regarding marketing and financing alternatives for federal power, as well as enter into discussions directly with other potential investors; and

- Resolve lingering legal questions

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ENDNOTES

[1] Statement of G. Edward Dickey, Acting Principal Deputy Assistant of the Army Before the Senate Committee on Energy and Natural Resources, February 26, 1991.

[2] Due to funding reductions no screening, reconnaissance, or feasibility level studies were conducted.